National High Magnetic Field Laboratory
Operated by Florida State University, University of Florida, Los Alamos National Laboratory
Florida State University, 1800 E. Paul Dirac Dr., Tallahassee, Florida 32310

MEMORANDUM

From: D. McRae, R.P. Walsh, Materials Development & Characterization Group
Date: 04/23/14
Re: Tensile tests on 100 bar heat treated Bi-2212 round wire at 4.2 K
Report No.: MD&C- 14-009

INTRODUCTION:

Tensile testing has been performed in the past on Bi-2212 round wire (report no. MD&C-EM07-022), in which the general scope was to obtain stress-strain behavior for modeling purposes. The specimens were observed to have non-linear behavior over the entire stress range, so curve fits were applied for the most accurate possible prediction. With the development of the overpressure heat treatment process, it is necessary to re-characterize the new wire's stress-strain behavior.

EQUIPMENT:

A 250 kN capacity MTS servo-hydraulic test machine fitted with a cryo-capable load frame and cryostat was used for this test series. Force was measured with a 5 kN capacity load cell (accuracy ± 0.1%), and an ASTM 83-06 Class B-1 extensometer measured strain in a 1" gage section. The output pressure of the machine's hydraulic pump was reduced from 3000 psi to 500 psi to minimize vibration-induced noise in the load cell signal (noise amplitude was noted to be well under 1 N), and the lightest weight hardware available was used to reduce hanging weight on the specimen, allowing stress-strain data capture to begin as low as possible (see Figure 1).

SUMMARY and RESULTS:

A total of eight (8) specimens were delivered for testing. Six were from one heat treatment, and the other two were from another (all the same heat treatment process). Table I shows specimen IDs, diameters, and densification after heat treatment (courtesy: Matras, Jiang).

Table I - Specimen ID and dimensions

Sample	avg. Ø (mm)	densif. %
140313-120822-E4 HT	1.3056	-1.567145832
140313-120822-E5 HT	1.2567	2.549956106
140313-120822-E6 HT	1.2637	1.725535077
140313-120822-E7 HT	1.2367	3.790801465
140313-120822-E8 HT	1.2226	4.777450097
140313-120822-E9 HT	1.2903	-0.258820324
140313-080221-E10 HT	1.2657	0.946617278
140313-080221-E11 HT	1.2405	3.230867015

Figure 1 - Specimen loaded in test fixture

Specimen E4 was tested at 77 K first as a preliminary check to ensure the settings and tuning of the test machine would work well for these delicate specimens. Subsequently, specimens E5 thru E8 as well as E11 were tested at 4.2 K, as these were considered to be the best-processed wires. Stress-strain curves for the 4.2 K tests are shown in Figure 1.
The data is trimmed just before the sharp yield point (see Appendix 1 for a curve of an entire test) to facilitate appropriate curve-fitting. The general behavior of the new specimens is notably different than that of the 2010 specimens (see Appendix 2). The most apparent discrepancy is specimen E8, which appears to act far “stiffer” than the others. E8 is noted to have densified appreciably more than the rest, which may potentially be correlated to its mechanical performance, but this assumption does not fit with the other four specimens. However, specimens E5, E6, E7 and E11 exhibit nearly identical behavior amongst each other and appear to be the most representative of the bulk material. MS&T Analysis group will use the stress-strain data for the application of curve fits and for finite element modeling.

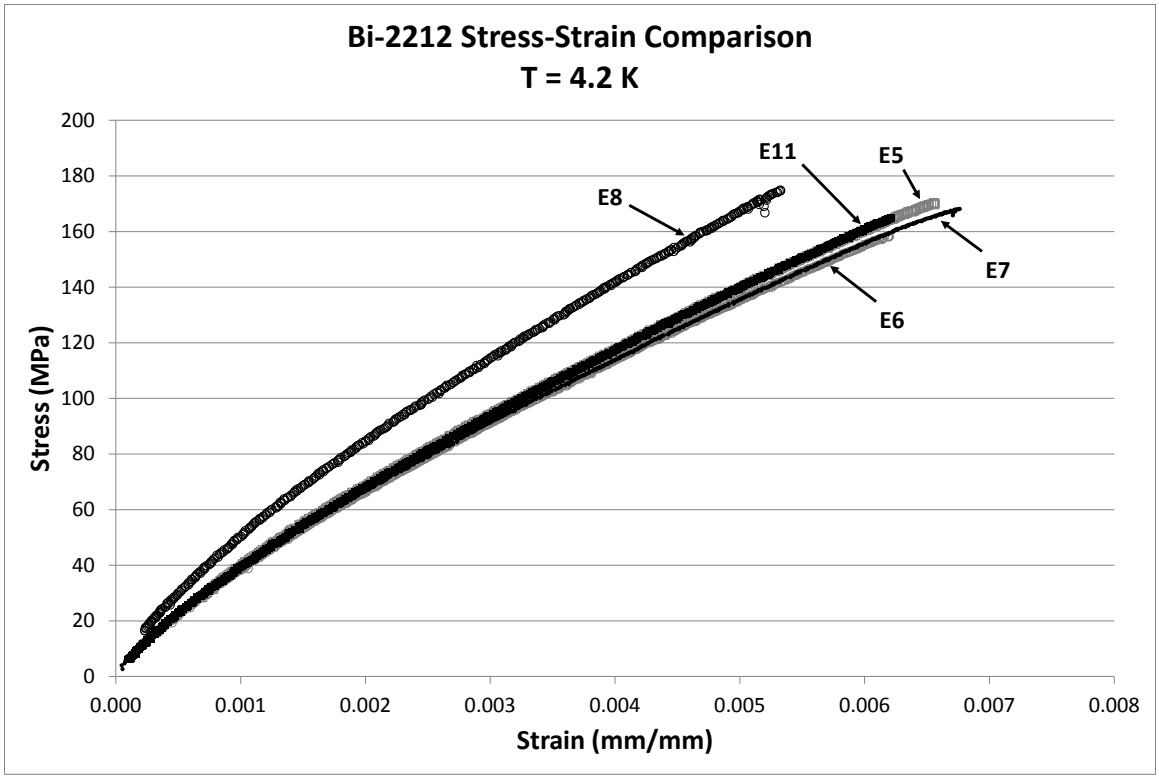
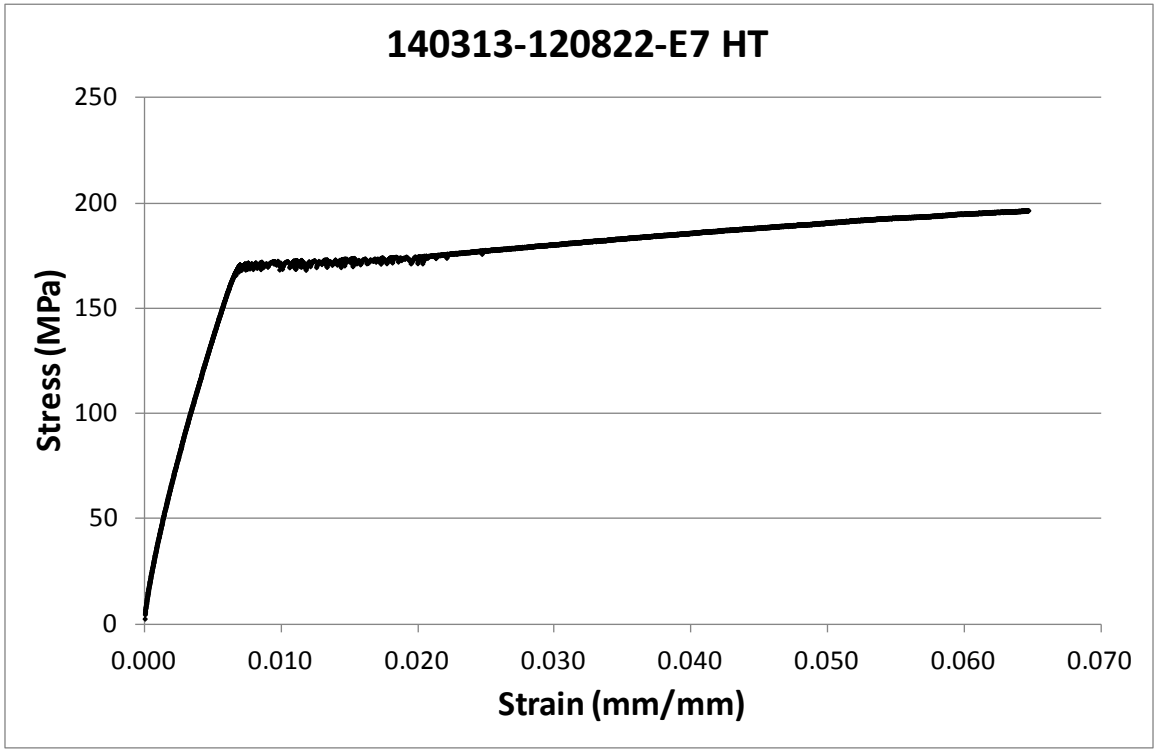
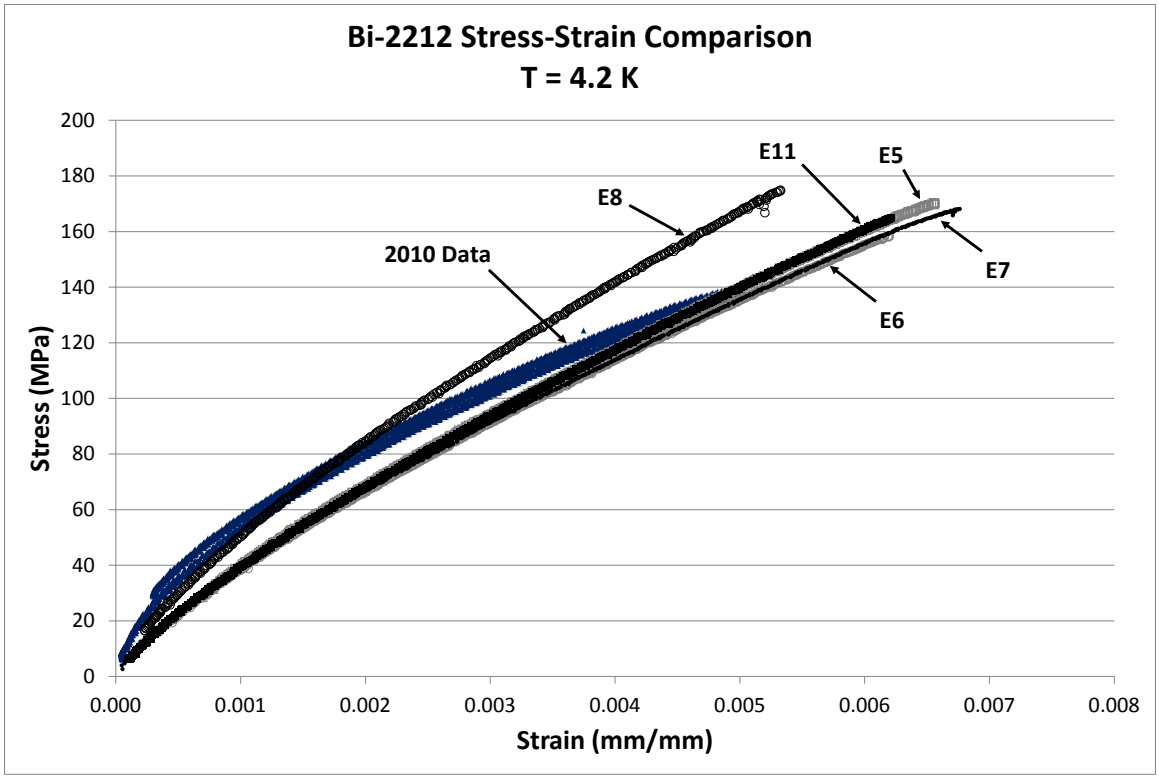


Figure 2 - Stress-Strain behavior at 4.2 K

APPENDIX:



Appendix 1 - Example of an entire tensile test



Appendix 2 - Comparison with 2010 data